# A New Combination in *Heterophyllium* (Bryopsida, Sematophyllaceae), with a Key to the Himalayan Species

*Yu Jia*

Institute of Botany, Chinese Academy of Sciences, Beijing, 100093, People's Republic of China.
yjia@ibcas.ac.cn

*Si He and Marshall R. Crosby*

Missouri Botanical Garden, P.O. Box 299, St. Louis, Missouri 63166-0299, U.S.A.
si.he@mobot.org; marshall.crosby@mobot.org

Abstract. An evaluation of Asian *Brotherella* Loeske ex M. Fleischer reveals that a new combination in the genus *Heterophyllium* (Schimper) Kindberg is necessary to replace *B. amblystega* (Mitten) Brotherus for its noticeably dimorphic stem and branch leaves, strongly serrate leaf apices, differentiated alar cells in an excavate group, erect and symmetric capsules, and strongly papillose spores. *Heterophyllium amblystegum* (Mitten) Y. Jia, S. He & Crosby is here validated and lectotypified along with a full description and a key to the Himalayan species of *Heterophyllium*.

*Key words:* *Brotherella*, Bryopsida, *Heterophyllium*, Himalayas, *Pylaisiadelpha*, Sematophyllaceae.

The circumscription of the genus *Brotherella* Loeske ex M. Fleischer has been in revision since Loeske (1910) first proposed it invalidly, on the basis of two infrageneric groups of *Stereodon* Mitten in Brotherus (1908): subgenus *Heterophyllium* (Schimper) Lindberg and subgenus *Pseudo-Rhaphidostegium* Brotherus. While validating the genus, Fleischer (1914) modified its delimitation by excluding those species once placed in the subgenus *Heterophyllium* (Brotherus, 1908). Brotherus (1925) basically followed the concept of Fleischer (1914) in recognizing the generic status of *Brotherella*. Since then, *Brotherella* has been widely accepted until Buck (1984) recently proposed the replacement of *Brotherella* by *Pylaisiadelpha* Cardot. However, Ando et al. (1989) argued that the two genera are distinct from each other and maintained the same generic concept of Fleischer (1914) on *Brotherella*. Most recently, Buck and Goffinet (2000) yet again recognized *Brotherella* and *Pylaisiadelpha* as two independent genera, which also represents the opinion of the present paper.

A study of Asian *Brotherella* reveals that one of its species, *B. amblystega* (Mitten) Brotherus has been misplaced in its current genus. Our examination of the type specimens of this species uncovers several critical features that do not fit into the circumscriptions of *Brotherella* and *Pylaisiadelpha*, but are more characteristic of *Heterophyllium* (Schimper) Kindberg (see Table 1). The distinct features are the regularly pinnately branched stems, the dimorphic stem and branch leaves with long-acuminate and strongly serrate apices; the differentiated alar region consisting of enlarged, reddish brown, and thick-walled cells forming an excavate group; the erect and symmetric capsules; the perfect peristome with a high basal membrane and two cilia; and the distinctly papillose spores. Buck (1998) rightly stated that the genus *Heterophyllium* was readily recognized by the long-acuminate leaves with gradually tapered, strongly serrate acumina and well-differentiated alar cells in an excavate group. Based on the morphological features of *B. amblystega*, the following new combination is necessary. Although *Index Muscorum* (Wijk et al., 1962, 1969) attributes the combination *H. amblystegum* to "Musci Fl. Buitenzog 4: 1174, 1923," Fleischer (1923) provided no direct or indirect reference to any basionym there, citing only "H[eterophyllium] amblystegum [sic]," i.e., there is not any indication of a basionym author. In page 1697 of the index, Fleischer (1923) cited only H. "amblystegum (Wils.) Flsch." Therefore, we are treating these as invalid. It may be noted that, of the slightly more than 400 new combinations attributed to Fleischer's *Musci der Flora von Buitenzorg* in the *Index Muscorum*, many were proposed in exactly the same way, i.e., not even indirect indication of basionyms was given. There are several instances in *Glossadelphus* on page 1352 (Fleischer, 1923). These should be studied and validated on a case-by-case, as-needed basis.

**Heterophyllium amblystegum** (Mitten) Y. Jia, S. He & Crosby, comb. nov. Basionym: *Stereodon amblystegus* Mitten, J. Proc. Linn. Soc., Bot., Suppl. 2: 97. 1859. *Brotherella amblystega*

Table 1. Character comparisons of *Brotherella*, *Pylaisiadelpha*, and *Heterophyllium*.

| | *Brotherella* | *Pylaisiadelpha* | *Heterophyllium* |
|---|---|---|---|
| Plants | ± complanate | usually not complanate | not complanate |
| Stems | irregularly branched or rarely subpinnately branched | irregularly branched | subpinnately to pinnately branched |
| Leaves | stem and branch leaves not clearly differentiated; upper margins serrulate to serrate, or nearly entire | stem and branch leaves not clearly differentiated; upper margins denticulate or nearly entire | stem and branch leaves differentiated; upper margins strongly serrate |
| Alar cells | usually enlarged and inflated, consisting of a row of rather thin-walled cells at base | not conspicuously enlarged or inflated | enlarged, subquadrate, thick-walled, forming an excavate group |
| Capsules | strongly inclined to nearly horizontal, ± asymmetric | erect to slightly inclined, symmetric | erect to somewhat inclined, symmetric or asymmetric; |
| Peristome | peristome perfect; basal membrane often higher than 1/3 the height of the teeth; cilia poorly developed or 1 to 2, delicate | peristome rather imperfect, basal membrane often lower than 1/3 the height of the teeth; cilia rudimentary or absent | peristome perfect; basal membrane often higher than 1/3 the height of the teeth; cilia (1 to)2 to 3, long |
| Spores | smooth or only faintly roughened | minutely papillose | nearly smooth or strongly papillose |

(Mitten) Brotherus, Nat. Pfl., ed. 2, 11: 425. 1925. *Pylaisiadelpha amblystega* (Mitten) W. R. Buck, Yushania 1(2): 11. 1984. TYPE: [India.] Sikkim: *J. D. Hooker 973* (lectotype, designated here, NY; duplicate, BM). Figure 1.

Plants medium-sized to rather robust, brownish yellow or golden yellow, caespitose; main stems creeping, regularly pinnately branched; branches 0.1–0.2 mm diam., 2.4–4.2 × 0.2–0.3 mm with leaves; stem in transverse section round, ca. 0.4 mm diam., cortical cells in 3 layers, irregularly rounded, medullar cells thin-walled, irregularly rounded quadrate, central strand absent; pseudoparaphyllia few, foliose on stems and branches. Leaves dimorphic, imbricately appressed when dry, patent to squarrose when moist; stem leaves broadly lanceolate with long, slender, flexuose acumina, strongly serrate above, 1.8–2.1 × 0.3–0.5 mm; median leaf cells linear-rhomboidal, 45.77–78.88 × 3.66–5.09 μm; alar cells in an excavate group with 12 to 16 reddish brown, inflated, rectangular or subquadrate, thick-walled cells, 21.28–37.50 × 11.20–23.68 μm; branch leaves narrowly lanceolate with slender acumina, 1.2–1.4 × 0.2–0.3 mm; alar cells fewer, 6 to 12 in number. Dioicous. Inner perichaetial leaves narrowly lanceolate, long-acuminate, serrate above, 2.5–3.0 × 0.3–0.4 mm, costae absent; outer perichaetial leaves smaller. Setae reddish, smooth, twisted when dry, 3.5–4.0 cm long; capsules oblong-ovoid, ca. 1.5 mm long, 1.0 mm diam.; opercula not seen; annuli not clearly developed; peristome double; exostome teeth yellowish brown, narrowly triangular, ca. 350 μm long, coarsely papillose above, cross-striolate below; endostome segments yellow, slenderly lanceolate, keeled, nearly as long as the teeth; basal membrane high, 1/3–1/2 as high as the segments; cilia (1)2 to 3. Calyptrae not seen. Spores spherical, large, 26–31 μm diam., strongly papillose.

Gangulee (1980) reported two species of *Heterophyllium* from the Himalayas: *H. confine* (Mitten) M. Fleischer from Bhutan and *H. renitens* (Mitten) Brotherus from Sikkim. The former was synonymous with *H. affine* (Hooker) M. Fleischer by Tan and Jia (1999), while the latter is now widely accepted in the genus *Herzogiella* Brotherus (Iwatsuki, 1970). At present, only *Heterophyllium affine* is known from the Himalayas. *Heterophyllium amblystegum* is different from *H. affine* as explicitly shown in the following key.

Key to the Himalayan Species of *Heterophyllium*

1a. Plants autoicous; leaves erectopatent when moist, erect and appressed when dry; leaf apices flexuose; margins often narrowly reflexed below; alar cells differentiated by a group of enlarged, rectangular, yellowish cells; capsules slightly inclined, cylindrical, asymmetric; cilia 1 to 3; spores nearly smooth. . . . . *H. affine*

1b. Plants dioicous; leaves patent to squarrose when moist, imbricately appressed when dry; leaf apices straight or slightly recurved; margins plane; alar cells differentiated by a group of moderately inflated, subquadrate, brown or reddish brown cells; capsules erect, oblong-ovoid, symmetric; cilia (1)2 to 3; spores strongly papillose. . . . . *H. amblystegum*

*Acknowledgments.* We thank the curators of BM and NY for the loans of the type specimens cited in this study. This work was supported by the National Nature Science Foundation of China (No. 30270113) and the U.S. National Science Foundation (grant DEB 0455568) for the *Moss Flora of China* project. The illustrations were drawn by Guo Mu-sen (PE). We are

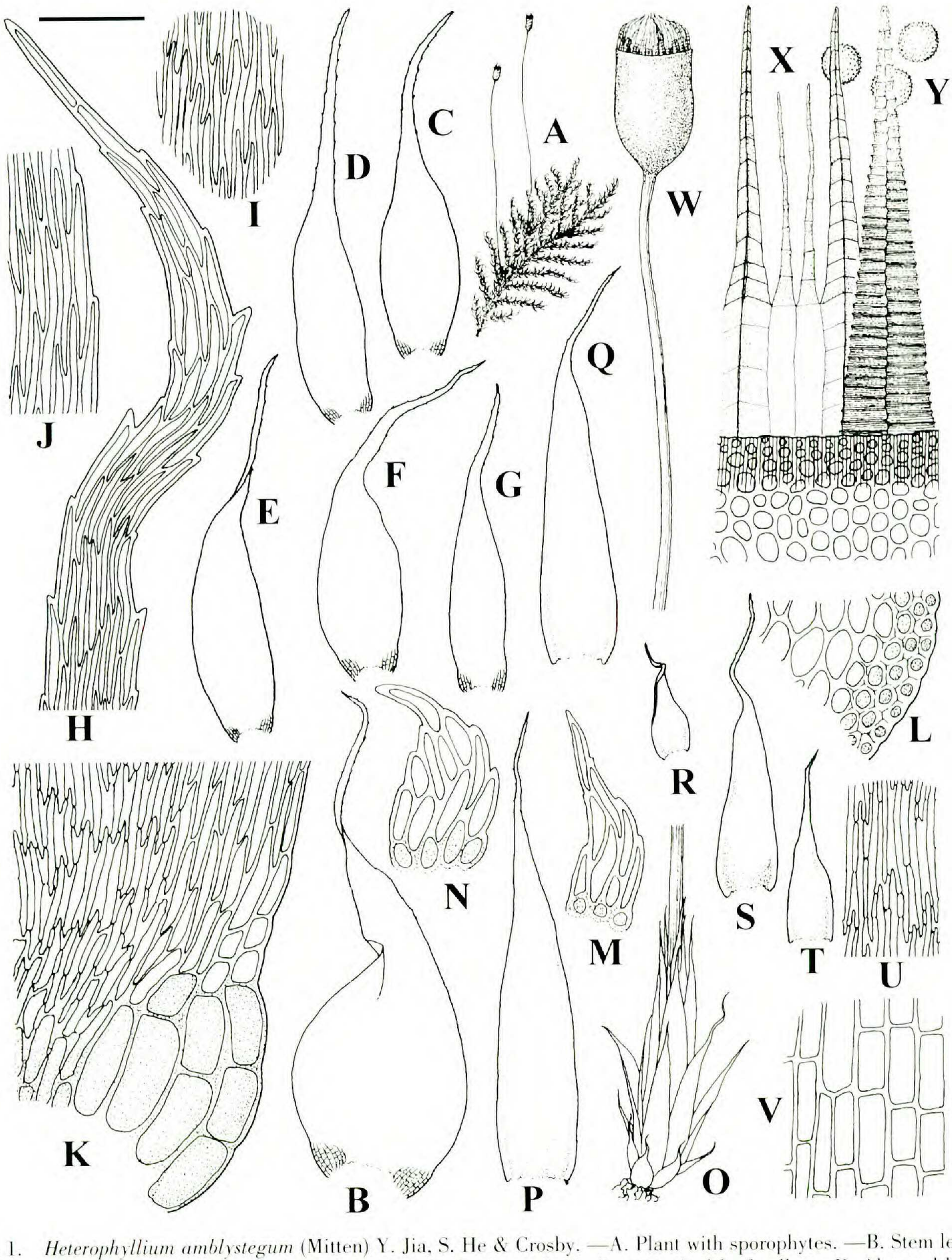


Figure 1. *Heterophyllium amblystegum* (Mitten) Y. Jia, S. He & Crosby. —A. Plant with sporophytes. —B. Stem leaf. —C–G. Branch leaves. —H. Apical leaf cells. —I. Median leaf cells. —J. Median marginal leaf cells. —K. Alar and basal leaf cells. —L. Portion of stem cross section. —M–N. Pseudoparaphyllia. —O. Perichaetia and portion of seta. —P–Q. Inner perichaetial leaves. —R–T. Outer perichaetial leaves. —U. Median perichaetial leaf cells. —V. Basal perichaetial leaf cells. —W. Capsule. —X. Portion of peristome. —Y. Spores. All drawn from the duplicate *J. D. Hooker 973* (BM). Scale bars: A = 20 mm; B–G = 0.4 mm; H–K, M–N, U–V = 55 μm; L = 45 μm; O = 0.9 mm; P–T = 0.6 mm; W = 1.45 mm; X = 85 μm; Y = 70 μm.

grateful to William R. Buck and Benito C. Tan for their valuable comments on the manuscript.

Literature Cited

Ando, H., T. Seki & W. B. Schofield. 1989. Generic distinctness of *Brotherella* from *Pylaisiadelpha* (Musci). Bryologist 92: 209–215.

Brotherus, V. F. 1908. Hypnaceae. *In* A. Engler & K. Prantl (editors), Die natürlichen Pflanzenfamilien, 1st ed. I(3): 1020–1095. Wilhelm Engelmann, Leipzig.

———. 1925. Sematophyllaceae. *In* A. Engler (editor), Die natürlichen Pflanzenfamilien, 2nd ed. 11: 404–445. Wilhelm Engelmann, Leipzig.

Buck, W. R. 1984. *Pylaisiadelpha* replaces *Brotherella* (Sematophyllaceae). Yushania 1(2): 11–13.

———. 1998. Sematophyllaceae. *In* Pleurocarpous Mosses of the West Indies. Mem. New York Bot. Gard. 82: 339–381.

——— & G. Goffinet. 2000. Morphology and classification of mosses. Pp. 71–123 *in* A. J. Shaw & B. Goffinet (editors), Bryophyte Biology. Cambridge Univ. Press, Cambridge.

Fleischer, M. 1914. Laubmoose. Nova Guinea 12: 109–128.

———. 1923. Die Musci der Flora von Buitenzorg 4: i–xxxi, 1104–1729. E. J. Brill, Leiden.

Gangulee, H. C. 1980. Mosses of Eastern India and Adjacent Regions, Fasc 8. Published by the author, Calcutta.

Iwatsuki, Z. 1970. A revision of *Plagiothecium* and its related genera from Japan and her adjacent areas, I. J. Hattori Bot. Lab. 33: 331–380.

Loeske, L. 1910. Studien zur Vergleichenden Morphologie und Phylogenetischen Systematik der Laubmoose. M. Lande, Berlin.

Tan, B. C. & Y. Jia. 1999. A preliminary revision of Chinese Sematophyllaceae. J. Hattori Bot. Lab. 86: 1–70.

Wijk, R. van der, W. D. Margadant & P. A. Florschütz. 1962. Index Muscorum, Vol. 2 (D–H). Regnum Veg. 26.

———, ——— & ———. 1969. Index Muscorum, Vol. 5 (T–Z, Appendix). Regnum Veg. 65.